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FOREST PEST MANAGEMENT
Pacific Southwest Region

81 2591

Report No. 81-15

3430 Evaluation
August 10, 1981

AN EVALUATION OF EXISTING AND POTENTIAL FOREST DISEASE AND INSECT PROBLEMS IN THE CATAVEE AND KINNIKINNICK CAMPGROUNDS, PINERIDGE RANGER DISTRICT, SIERRA NATIONAL FOREST

PSW FOREST AND RANGE EXPERIMENT STATION
AUG 27 1981
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ABSTRACT

We evaluated Catavee and Kinnikinnick campgrounds on the Pineridge Ranger District, Sierra National Forest, for existing and potential pest problems. Significant disease organisms and insects in the campgrounds include Fomes annosus, red fir dwarf mistletoe, lodgepole pine dwarf mistletoe, western gall rust, mountain pine beetle, Jeffrey pine beetle, and Ips engraver beetles. Densely stocked aggregates of vegetation constitute a potentially significant problem because of their declining vigor and increased risk to insect and disease attacks. Control options and management alternatives are presented that can minimize the impact of pests on existing and future vegetation. The alternatives address the campground rehabilitation options being considered by the District. Guidelines and maps showing problem locations are included.

INTRODUCTION

On June 22 and 23, 1981 we examined Catavee and Kinnikinnick Campgrounds for existing and potential pest problems. During the winter of 1981 the Forest Pest Management Staff supplied some general information, based on cursory observations, to the District (1920 memorandum of 2/26/81, copy attached). This report supplies more detailed information and specific management alternatives for the campgrounds.

On June 24, 1981, we met with personnel from the District and the Supervisor's Office (Lyle Wilkinson, Jack Clark, Don Waugh, Bob Fleming, Doug Piirto, Robin Faunt Le Roy, Don Woodson, Marily Reese). We made a walking tour of the campgrounds, discussing various alternatives on an individual site basis.

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OBSERVATIONS

The two campgrounds support an uneven-aged, mixed conifer stand, including red and white fir, and lodgepole and Jeffrey pine. Site quality was determined to be site class 60 (Dunning and Reineke). Stocking levels varied; however, the majority of the area was well-stocked to overstocked with basal areas up to 450 sq.ft./ac.

A number of insect and disease organisms were observed. The most significant, or potentially significant, insect and disease organisms included dwarf mistletoes in red fir (Arceuthobium abietinum f.sp. magnificae) and lodgepole pine (A. americanum), Fomes annosus in white fir, western gall rust (Peridermium harknessii) on lodgepole pine, mountain pine beetle (Dendroctonus ponderosae) in lodgepole pine, Jeffrey pine beetle (D. jeffreyi) in Jeffrey pine, and Ips sp. in green slash. Other, less significant pests included Elytroderma needle blight (Elytroderma deformans) on Jeffrey pine, yellow witches' broom (Melampsorella caryophyllacearum) on fir, and Armillaria root disease (Armillariella mellea) in fir. Additionally, a major agent of tree damage is snow breakage, particularly of lodgepole pine. The existence of hazardous trees and the likelihood of additional trees becoming hazardous is of concern in this and all developed recreation areas. The dwarf mistletoe and annosus root disease-infested areas are outlined on the enclosed maps.

BIOLOGIES OF PEST ORGANISMS

Much of this information was discussed in the preliminary report. However, some of the organisms were not covered and are included here, while others were erroneously included in our 2/26/81 memorandum.

Dwarf Mistletoes. The two dwarf mistletoe species in the campgrounds are host specific, infecting either red fir or lodgepole pine. The life cycle of dwarf mistletoes is similar and was discussed in the previous report.

Western Gall Rust. The hosts for this rust fungus include all species of hard pines; it was observed only on lodgepole pine in the campground areas. On lodgepole pine the principal symptoms are either bole galls or hip cankers. The fungus can survive in these galls and cankers for many years and produce orange spores in the spring that directly reinfect the pine. The fungus can kill seedlings, but usually does not directly kill larger trees. However, the bole galls and cankers may weaken the trunk sufficiently to result in stem breakage.

Bark Beetles. Most pine and fir trees which die in any particular year are infested with bark beetles at the time they expire. Tree mortality can be significantly postponed or avoided if bark beetle infestations can be prevented or suppressed.

The most aggressive beetles in this area are the Jeffrey pine beetle in Jeffrey pine, the mountain pine beetle in lodgepole pine, and the fir engraver (Scolytus ventralis) in true fir. Infestations are usually

initiated when trees lack adequate moisture; therefore, drought, excessive competition, and the impacts of tree diseases and injuries eventually bring on bark beetle infestations.

There are other bark beetles in the area, such as pine engravers (Ips spp.) and red turpentine beetle (D. valens) in pines and Scolytus spp. and twig beetles in true firs. The pine engravers and Scolytus spp. are attracted to green slash (breeding material) in the spring and may breed up sufficient numbers to attack and kill small trees or the tops of larger trees. The pine engravers, for example, continuously reoccur in the common snow breakage in lodgepole pine. There is also some risk in cutting trees and leaving green slash, particularly in the spring and early summer. Ips and D. valens injury frequently precede more lethal attacks by other bark beetles.

PEST CONTROL

Control methodologies for individual insects and diseases were provided in our 2/26/81 report. Lodgepole pine and red fir dwarf mistletoes can be managed similarly to western dwarf mistletoe. However, broom pruning is not recommended because of the many problems with lodgepole pine in the campgrounds and the likelihood of loss of individual trees from other causes, notably snow breakage. The effect of broom pruning red fir is not known. Brooms in red fir are mainly at considerable heights in old-growth predominants.

For bark beetles, methods of prevention (called mitigation of predisposing factors or conditions in our 2/26/81 report) would be applicable if campground rehabilitation or reconstruction is carried out. This is about the only opportunity for logging, thinning, pruning, etc. to take place in the campground environment. Other methods of bark beetle control (direct population reduction and individual tree protection in our 2/26/81 report) are usually viewed as less effective or as temporary means of dealing with bark beetles. However, direct control and individual tree protection do have a place in Integrated Pest Management. For example, if you anticipate that the disturbance from construction and vegetation management work itself might lead to a temporary stress on certain pine trees, then you might opt for using a protective spray to prevent attack by bark beetles and thereby gain time for the trees to recover. If, subsequently, bark beetle infestations do occur, direct control may be deemed the appropriate action.

MANAGEMENT OPTIONS

1. Do Nothing. No action will result in continued, and possibly increasing, tree mortality in the campgrounds. The amount of dwarf mistletoe in individual trees will intensify, causing increased moisture and nutrient stress, and improve the likelihood that they will be successfully attacked by bark beetles. Also, the dwarf mistletoes may spread to uninfested host trees in the campgrounds.

Valuable and very attractive trees likely to die unless relief is provided in the next few years are the large predominant Jeffrey pines. These trees are presently stressed by the large amount of surrounding vegetation (true fir understory). During any period of moisture stress their resistance to Jeffrey pine beetle attacks will be lowered. The predominant red fir are additional candidates for mortality, especially those infested heavily by dwarf mistletoe.

Continuing to not treat freshly cut coniferous stumps with borax will increase the probability that new annosus root disease centers will become established. This would result in additional mortality and the creation of hazardous, root- and butt-rotted true firs.

2. Campground Rehabilitation. This equates to Alternative No. 3 in the Environmental Assessment. Vegetation management is a principal component of this alternative. This would entail reducing the stocking to more suitable levels of 200 to 250 sq.ft./ac. Maintaining and planting shrubs in the campground for screening would require a further reduction in tree stocking. Proper selection of individual trees for removal could benefit the campgrounds in several ways: future mortality would be reduced, potentially hazardous trees would be removed, the impact of dwarf mistletoe could be reduced, high bark-beetle-risk trees would be removed, and a generally better health and vigor of the residual stand would be achieved.

Because of the number of trees that would be removed, it would be imperative that borax be applied to stumps to reduce the possibility of F. annosus infection. The thinning should be planned for late summer and early fall to reduce the risk of pine engraver beetle populations building up. If scheduling does not permit activities at this time of year, expensive slash disposal techniques (mechanical, chemical treatment, or removal) might be required. Another advantage to late summerearly fall activities is that damage to the residual stand is reduced because bark slippage is less than in the spring. This is particularly important for true firs, which are highly susceptible to decay through basal wounds in contact with the ground.

3. Campground Reconstruction. This equates with Alternatives 1 and 2 in the Environmental Assessment. Many of the concerns and advantages expressed above in Option 2 apply. The principal method of pest management would be through vegetation management. A healthier, more vigorous stand could be achieved through proper tree selection.

In addition to vegetation management, rerouting of roads and new placement of campsites could utilize existing annosus root disease centers or serve as partial buffers to limit the spread of dwarf mistletoe. If root disease centers are to be used, all infected trees must be removed, preferably including the stumps and root systems. Green trees on the margins of centers would have to be removed because they are probably infected. Because F. annosus was found only in fir, only the true firs would have to be removed; pines could be retained. If these root disease centers are to be revegetated, true firs should not be utilized because of their susceptibility to attack by the fungus.

During reconstruction, care should be taken to minimize basal wounding and root cutting residual vegetation. Following reconstruction, damaged trees should be removed. Attempts should also be made to minimize alterations in drainage patterns and compaction.

Enclosed is a set of marking guidelines that may be used during selection of trees for removal. These guidelines can provide a basis for tree selection during thinning operations, although the person doing the marking, in consultation with other specialists, should provide the final decision.

Forest Pest Management personnel are available to provide additional assistance if needed.

MARKING GUIDELINES

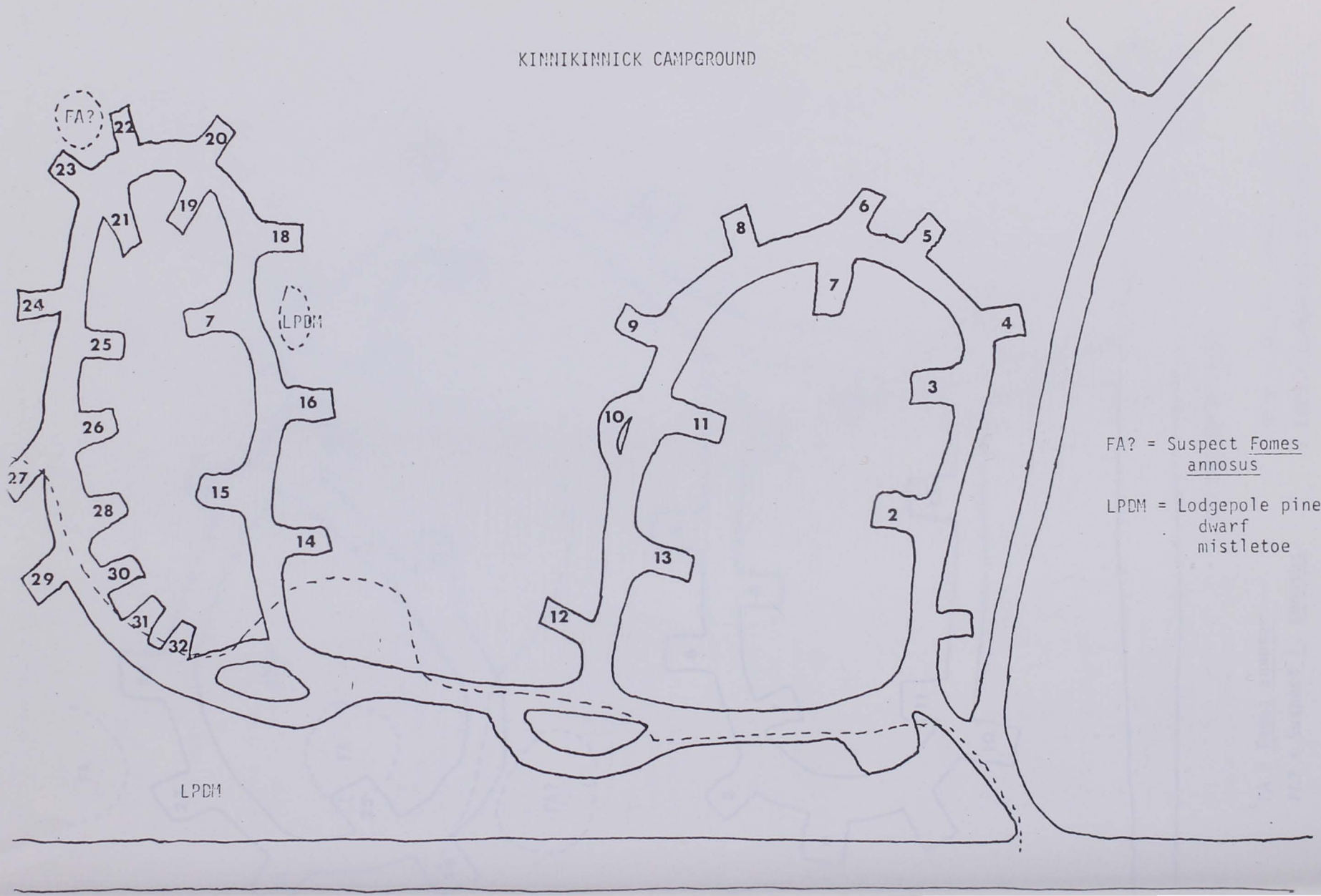
Understory

- Reduce stocking to 200 to 250 sq.ft./ac.
- Reduce stocking further in immediate vicinity of predominant Jeffrey pines and true firs.
- A denser understory may be retained as screening in linear hedge-like patches, if desired.
- Remove dwarf mistletoe-infected lodgepole pines and discriminate against infected red fir.
- Remove trees with basal scars, especially firs.
- Remove obviously suppressed trees with poor live crown ratio (< 30% LCR).

Overstory or Future Overstory

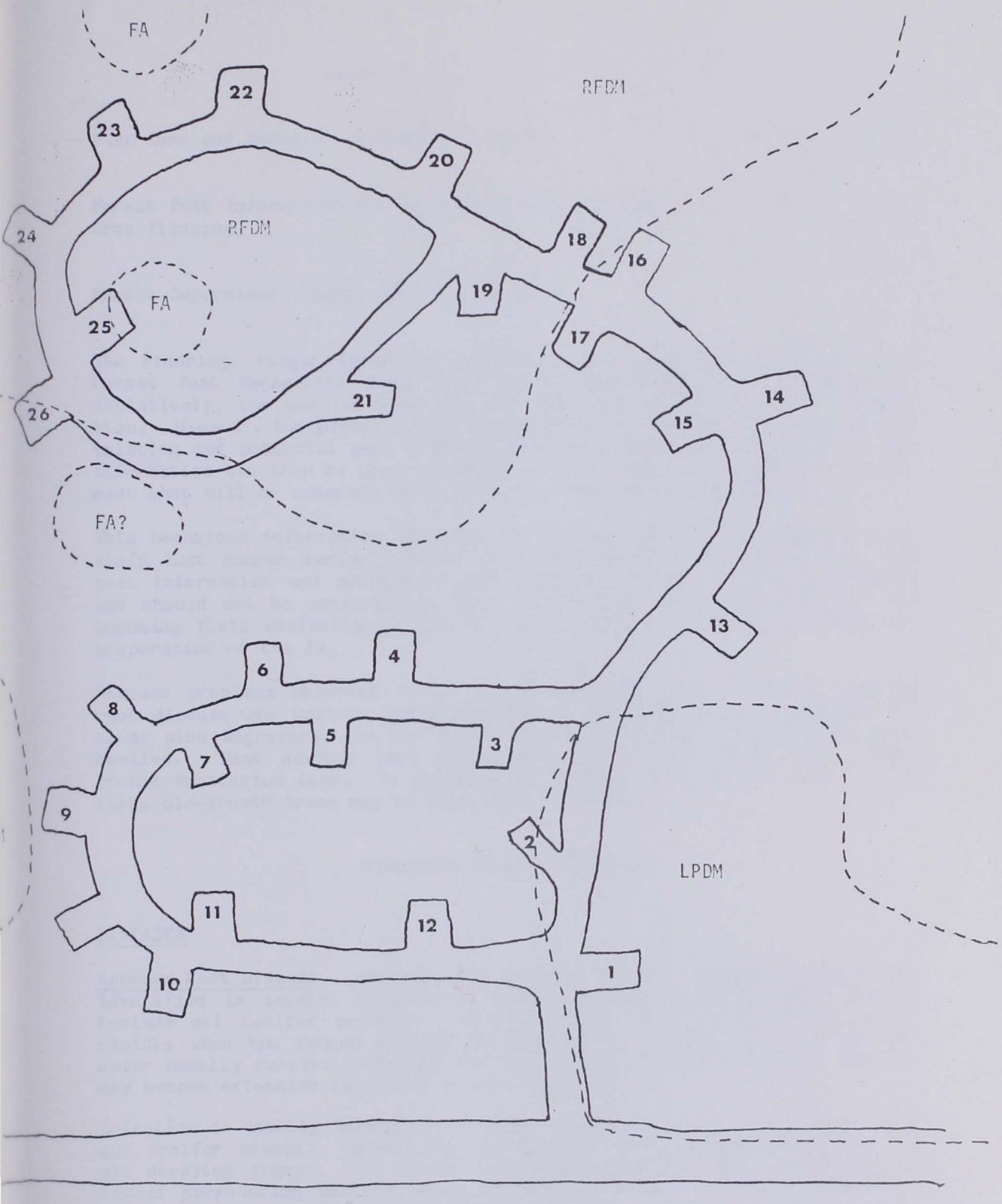
- Follow Keen's risk-rating for Jeffrey pine (see attached), removing Risk Classes III and IV. (Also see R-5 Supplement #108, 9/71, FSM 2471.23--3.)
- Remove dwarf mistletoe-infected pines and firs with 6-class ratings of 5 and 6.
- Select against lodgepole pine that have severe bole cankers or have large forks.
- Remove trees with open basal scars that have advanced decay in the roots or bole.
- Select against true firs in the immediate vicinity of annosus root disease centers.
- Select against red firs with dwarf mistletoe bole cankers that have a decayed face.
- Select against firs with old dead tops.

KINNIKINNICK CAMPGROUND



FA? = Suspect Fomes annosus

LPDM = Lodgepole pine dwarf mistletoe



CATAVEE CAMPGROUND

FA = Fomes annosus

FA? = Suspect F. annosus

RFDM = Red fir dwarf mistletoe

LPDM = Lodgepole pine dwarf mistletoe

Region 5

1920 Land and Resource Management Planning February 26, 1981

Forest Pest Information for Huntington Lake Recreation Area Planning

Forest Supervisor, Sierra National Forest

The Pineridge Ranger District requested a biological evaluation from the Forest Pest Management staff for Catavee and Kinnikinnick Campgrounds. Tentatively, the week of June 22, 1981 has been set for the field inspection. However, the District has requested some preliminary information on existing and potential pest problems pertinent to these campgrounds. This information can then be used by the district in their Environmental Assessment that will be underway prior to the planned field assistance.

This technical information is based on observations made by members of my staff last summer during a brief inspection of the two campgrounds. The pest information and management alternatives discussed below are general and should not be construed as being complete or as a substitute for the upcoming field evaluation. However, the information should be useful for preparation of the EA.

Disease problems observed in or around the campgrounds included annosus root disease and western dwarf mistletoe. Potential insect problems include pine engravers, the fir engraver and the western and mountain pine beetles. Past surveys have indicated slight to moderate ozone injury around Huntington Lake. In addition to insects and diseases, some of the large old-growth trees may be potentially hazardous.

BIOLOGIES OF PEST ORGANISMS

DISEASES

Annosus Root Disease. Annosus root disease, caused by Fomes annosus, was identified in several campgrounds around Huntington Lake. Host species include all conifer species. Infected pines are usually killed rather rapidly when the fungus girdles the root collar. True firs and incense-cedar usually survive infection for many years, although butt and root rot may become extensive resulting in tree weakening.

Infection is usually initiated by aerial deposition of spores onto freshly-cut conifer stumps. Spores are produced by conks located principally in old decaying stumps. The fungus then grows into the root system and can invade surrounding healthy trees where root contact occurs. Underground spread can continue between infected and healthy trees via root contacts causing expanding centers of mortality. In general, infections will cross

from pine to true firs; however, rarely is the fungus observed to go from true fir to pine. Also, infection of true fir may take place by spore invasion of fresh wounds on living trees. Most hardwoods are highly resistant or immune.

Western Dwarf Mistletoe. Western dwarf mistletoe, Arceuthobium campylopodum, was noted in low levels in the campgrounds. This parasitic seed plant infects ponderosa, Jeffrey, Coulter, and knobcone pines. It requires living host tissue to survive. Seeds produced by the mistletoe plant are forceably discharged and usually travel unimpeded 20 to 50 feet, although longer transport distances can occur. After being intercepted by needles or small twigs, the seeds germinate and infect the twig. In two to four years mistletoe shoots are formed and produce reproductive structures in an additional two to four years. Moderate to heavy infection of pine causes reduced growth and increased susceptibility to bark beetle attack.

INSECTS

At the time of the brief visit last summer, no significant insect activity was observed in either Catavee or Kinnikinnick campground. However, pine engraver (Ips spp.) broods were observed developing in lodgepole pine slash in nearby Deer Creek campground.

The California fivespined ips, Ips paraconfusus. This pine engraver is perhaps the most important pine engraver in the central and Southern Sierra and attacks all species of pine within its range. It prefers to breed in fresh, green slash and most problems develop when there is an abundance of such material available in the spring and early summer. I. paraconfusus can cause top-killing of large trees as well as mortality of trees up to about 25 inches DBH, primarily when populations build up in slash and/or trees are under stress (drought). In the Huntington Lake area, the beetle commonly completes 2 to 3 generations per year and sometimes a fourth. Top-killing by I. paraconfusus is often followed by western pine beetle attacks in the mid-and lower bole.

Western pine beetle (WPB), Dendroctonous brevicomis. The WPB attacks both ponderosa and Coulter pine and generally undergoes 2 generations per year around Huntington Lake. Successful attacks always result in the death of the host. Under "normal", endemic conditions, the WPB usually attacks single trees or small groups of trees that have been weakened by some predisposing factor(s), such as root disease, dwarf mistletoe, oxidant air pollution, mechanical injury, drought, overstocking, advanced-age, or fire. Attacks on vigorous, healthy trees at "normal" population levels are frequently unsuccessful. However, particularly when large numbers of predisposed, weakened trees are available, healthy trees can also be killed. This comes about through a behavioral mechanism called "mass attack". Adult WPB that initiate a successful attack on a host release an aggregating chemical called a pheromone, which attracts large numbers of other WPB to the tree, causing a "mass attack." When this occurs, depending on the proximity of other host trees, additional trees may be attacked and overcome. Healthy trees will be killed if attacked by sufficient numbers of beetles. The WPB does not breed in slash and attacks trees greater than 6 inches DBH. Initial attacks tend to concentrate around mid-bole and are

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evidenced by pitch tubes and reddish boring dust on the bark and in bark crevices, followed by a fading, sometimes gradual, of the foliage. In addition to F. paraconfusus, insects often found in association with the WPB include, the red turpentine beetle, D. valens, in the base of the tree, the California flatheaded borer, Melanophila californica, in the bole and larger branches, and other pine engraver beetles.

Mountain pine beetle (MPB), D. ponderosae. The MPB attacks several species of pine, including lodgepole, sugar and ponderosa. In California, MPB damage to the former hosts tends to be more important than to ponderosa pine, when it frequently acts secondarily to WPB. Also, in contrast to WPB, it has but one generation per year. As with WPB, attacks are more common in less vigorous trees.

Fir engraver, Scolytus ventralis. The fir engraver attacks most true firs, including white fir, in the west from pole size to overmature. Successful attack by S. ventralis can result in a) mortality, b) top-kill, and/or c) patch kill along the bole (small areas of the cambium killed that eventually heal over). It can take from 1 to 2 years to complete the life cycle. S. ventralis has a tendency to attack suppressed and intermediate trees. Increased fir engraver activity has been associated with poorly growing trees, heavy dwarf and true mistletoe infections, root disease, and areas that have had recent logging activity, particularly where a high proportion of mature trees are removed. S. ventralis can also breed in slash.

CONTROL ALTERNATIVES

The following are general actions that can be taken to reduce the impacts of the various pest organisms in the campgrounds. The "No Action" alternative has been omitted at this time.

Annosus Root Rot

1. Prevent stump infection. Application of granular borax to freshly cut conifer stumps is effective in preventing most (90%) new infections. The chemical is toxic to the spores of F. annosus, but has no effect on existing infections. Borax application is required on all coniferous stumps cut in and near developed recreation sites (FSM R-5 Supp. 2305 and 2331.33). Application requires the prior submission of a Pesticide-Use Proposal. Borax must be applied to stumps within two days after tree falling to be effective.

2. Species conversion. Revegetation of active annosus centers should be done only with resistant species. All conifers are susceptible to the fungus, but hardwoods are rarely infected. Leaving the centers barren or planting them with resistant hardwoods will result in the fungus eventually dying out so that conifers can again be regenerated. Unfortunately, this may take up to 50 or

more years. In mixed conifer stands with infected true firs, conversion to pines may reduce subsequent infection. Future annosus problems may be reduced by developing a good mix of hardwoods within the stand.

Western Dwarf Mistletoe

1. Thin the infected stand to reduce the level of stand infection and improve or maintain the vigor of residuals which will increase their resistance to bark beetles. Discriminate against trees with the heaviest levels of infection. Consider the removal of pines with 6-class dwarf mistletoe ratings of 5 and 6 because they have a high-probability of being infested by bark beetles and dying within 10 to 15 years. Also, bark beetle-infested trees can serve as foci for group kills.

   Favor non-host species as residuals in the selection criteria.

2. Witches brooms in residual trees may be pruned if at least one-third live crown remains after pruning. Removal of witches brooms will maintain tree vigor, but it will not necessarily stop the spread of dwarf mistletoe in the stand.

3. When regenerating openings in the stand, plant non-susceptible species. This will maintain a vegetation cover and reduce dwarf mistletoe spread by breaking up canopy-continuity.

4. Create a buffer strip between treated stands and surrounding infected stands, if needed. If possible, use natural barriers such as roads, streams, change in vegetation type, etc.

5. Conduct post-suppression surveys every two years for six years. Replan treatment stategies if the objectives are not met.

Hazardous Tree Reduction

Hazardous tree identification and removal is necessary in all recreation areas to safeguard people's lives and property. A hazardous tree safety program first requires planned periodic detection surveys to identify and correct hazardous tree situations. This survey should be done at least annually by individuals trained in the recognition of hazardous trees. Following detection, efforts should be made to remove hazardous trees as quickly as possible. Permanent records of survey results and actions taken should be maintained. In addition to hazardous tree removal, attempts to minimize formation of hazardous trees is necessary. This can include protecting residual trees during thinnings, consideration of potentially hazardous trees during placement of permanent structures, and education of public users to reduce their impact.

Bark Beetles

Bark beetle management options include: a) direct population reduction, b) individual tree protection, and c) mitigation of predisposing conditions or factors.

a. Direct population reduction. Direct control methods include locating, felling and treating infested trees a) with insecticides; b) by burning; c) by peeling the bark; d) by burying infested material; and e) by removing infested trees from the forest. Most of these methods have been shown to be effective in killing bark beetles, but they have not been demonstrated to reduce bark beetle populations to levels low enough in a given area to reduce tree mortality to an acceptable level. In addition, direct control techniques are considered to have an adverse effect on bark beetle natural enemies, which play a stabilizing role in the dynamics of bark beetle populations. Other methods, such as the use of behavior-modifying chemicals (e.g. pheromones) to manipulate bark beetle populations, are still in the experimental stage.

b. Individual tree protection. This approach has been developed specifically to prevent/reduce bark beetle-related mortality in situations where tree values are high and often not easily described in traditional dollar values. Under such conditions, relatively expensive, individual tree, prophylatic treatments using insecticides may be warranted. Currently, one chemical, Sevimol 4 carbaryl insecticide, is registered in California under EPA Special Local Need Registration No. CA 770318 as preventive treatment for pines against the western and mountain pine beetles. Experiments are currently being conducted to evaluate the efficacy of additional materials against the western pine beetle.

There are several factors to consider relative to this approach. First, treating only individual trees does not deal with the underlying factors that predispose trees to bark beetle attack. Second, efficacy depends to a large extent on getting good bole coverage with the spray, which can be very difficult with large trees. Third, no matter how carefully the insecticide is applied there will be some drift with a resulting potential effect on non-target organisms, including beneficials, both on and off the treated tree. Fourth, it is not yet completely clear how long a single treatment will remain effective and thus, how frequently re-treatment would be necessary to provide protection. However, recent research results indicate that Sevimol 4 can provide protection for one year to the part of the bole that was treated. Fifth, to the extent that the treatment would involve people and dollar resources and divert efforts from longer-term preventive action (e.g. vegetation management), overall effects might be negative.

Use of this approach requires careful consideration. One hypothetical situation could be where road or building construction or hazard/salvage tree removal causes damage to high value residual trees, predisposing them to bark beetle attack. Another circumstance might be when trees are under severe stress (drought). To the extent that such predisposition is temporary and will diminish as the tree recovers from the stress, a preventive treatment

during the "susceptible" period might be warranted. Although chemicals are registered for this purpose, this approach has not been evaluated over a variety of situations on an operational basis in California.

c. Mitigation of predisposing factors or conditions. As referenced above, bark beetle problems are usually associated with trees and stands that have become or been made susceptible by some predisposing factor. Management alternatives that prevent, reduce or alleviate these factors are advantageous in that they usually prevent damage from occurring rather than attempt to treat the problem after it already exists. These actions often have long-term beneficial effects and can be built into resource management plans and silvicultural prescriptions. In addition, managing for healthy, vigorous stands should reduce the impacts of non-manageable factors like drought.

Managing the vegetation to reduce the impact of bark beetles includes controlling stocking levels and species composition and regenerating areas where necessary. Vegetation management practices are compatible with, or part of, measures recommended to manage diseases and other insects. Overall, both Cataves and Kinnikinnick, as compared to Deer Creek, appeared to have a good species mixture which should help to reduce widespread mortality and provide greater silvicultural treatment flexibility.

Consideration of any vegetation management actions should be on an aggregation by aggregation basis. Some of the biologically advantageous actions may conflict with other resource objectives and/or political realities. It is expedient, therefore, to include silviculturists, recreation specialists, landscape architects, and other specialists as necessary, in addition to entomologists and pathologists, during any on the ground observations and vegetation management planning.

With respect to the pine engraver, the critical factor is to reduce the amount of green slash available during the spring and early summer by restricting slash producing activities until late August through early November. If slash is created in the spring, prompt slash disposal is critical. Methods include burning, chipping, trampling with heavy equipment, lopping and scattering, covering fresh slash piles with clear plastic in exposed areas to encourage heating and drying by solar radiation, and removal from the area. If burning is used care must be taken to avoid scorching nearby trees. If lopping and scattering is utilized, the material should be left in sunny, exposed openings, away from the bole of residual trees. Piling fresh slash without any treatment should be avoided.

This report was prepared to provide District personnel with information useful in their EA. More complete, site specific information will be supplied after the evaluation is performed. If there are any questions or additional information is required, please contact John Renz or Gregg DeMitto of my staff at (415) 556-6520.

WILFRED L. FREEMAN, JR.

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Director of Forest Pest Management

cc: Lyle Wilkinson Pineridge RD, Sierra N.F.

GDeMitto/crw

R-5 5290-31
3/30/61

PENALTY SYSTEM FOR RATING HIGH-RISK TREES
Ponderosa & Jeffrey Pine
Eastside Sierra & Southern California

	Penalty
A. Needle Condition	
1. Needle Complement	
a. Needle complement normal	0
b. Less than normal complement thr ugh crown. No contrast between upper and lower crown	2
c. Thin complement in upper crown, normal in lower crown.. Contrast evident between upper and lower crown	5
2. Needle Length	
a. Needle length normal	0
b. Needles shorter than normal throughout crown. No contrast between upper and lower crown	2
c. Needles short in top, normal below. Marked contrast	5
3. Needle Color	
a. Normal	0
b. Off color	2
c. Fading	8
B. Twig and Branch Conditions	
1. No twigs or branches dead	0
2. A few scattered dead or dying twigs or branches in crown	1
3. Many scattered dead or dying twigs or branches in crown.	2
4. Dead or dying twigs or branches in crown forming a definite weak spot or hole in crown, notably in top 1/3 of crown.	3
5. Dead or dying twigs on branches in crown forming more than one weak spot or hole in crown, notably in top 1/3 of crown	5
C. Top Crown Condition	
1. No top killing	0
2. Old top kill with no progressive weakness or killing in green crown	2
3. Old top kill with a progressive weakness or killing in green crown below	5
4. Current top killing	8
5. Broken top - recent, less than 1/3	5
6. Broken top - recent, more than 1/3	8
7. Broken top - old. No progressive weakness	2
D. Other Factors	
1. Lightning strikes - recently struck, no healing evident.	8
- healed strike	2
2. Dendroctonus valens attacks in base - current successful	6
- old pitched out	2

The following factors have local significance and will vary by area. We have little information on their importance, and the marker should weight these in light of his local observation and experience.

3. Mistletoe
4. Needle scale(various species)
5. Needle blight (Elytroderma deformans)
6. Rust (Cronartium sp.)

Risk Class	Penalty Score
I	0
II	1 to 4 inc.
III	5 to 7 inc.
IV	8 and higher

The above penalty values are to be used as a guide for training and cannot be considered as having any statistical significance. (Revised by R. C. Hall, 4/23/56.)

Beetle Susceptibility Risk Classes

(From "Sanitation Treatment for Insect Control," 1965, by Dr. R. C. Hall and J. R. Pierce)

Risk 1. Low Risk. Full foliaged, healthy appearing crowns. Foliage of healthy appearance, needles usually long and coarse, color good dark green. Practically all twigs with normal foliage complement. No weakened portions of crown.

Risk 2. Moderate Risk. Fair to moderately healthy crowns, imperfect in spots. Foliage mostly healthy, needle length average or better, color fair to good. Some twigs or branches may lack foliage, but such injury should not be localized to form definite "weak" spots in crown.

Risk 3. High Risk. Crowns of fair to poor health, somewhat ragged or thin in portions of crown. Foliage in parts of crown thin, bunchy, or unhealthy, needles average to shorter than average in length, color fair to poor. Some to many twigs or branches lacking foliage, some to many twigs or branches fading or dead. Small, localized, weakened portions of crown usually present.

Risk 4. Very High Risk. Crowns in poor condition, ragged or thin, often showing evidence of active insect infestations in upper portions. Foliage thin or bunchy, needles short or sparse, color poor, twigs and branches dead or dying, portions of crown definitely weakened. Active tonkilling or partial infestations often present. Needles short in upper crown, normal below; marked contrast.

Risk 5. Mechanical Risk. Trees 50 percent or more girdled by fire or logging damage or 50 percent or more of sound basal area eliminated by fire; trees which lean more than 30 degrees out of vertical; trees which, through removal of support (adjacent to road cuts) or disturbance of roots, are considered poor risks; trees struck by lightning.

Risk 6. Disease Risk. Trees of all species in which infection by disease is sufficiently established to very probably cause their death in the next 10 years.

The appearance of some trees may be adversely affected by characteristics which are not risk indicators. The following are not considered as being due to risk:

Snag Tops. A tree that has recovered from a former top kill is termed a snag top. Although deterioration of the remaining crown often follows, the snag top alone is not considered a characteristic of risk. When the remaining parts of the crown are vigorous and healthy, such trees can be considered low risk.

Mule Tail Foliage. In some trees the foliage has a distinctly bunchy appearance, although the needles are long. This apparently is due to a peculiar development of the branches and is a normal characteristic of a certain strain or type of pine tree. It should be ignored in classifying risk unless caused by dwarf mistletoe or needle blight infection.

Off Color Caused by Weather. Needles may turn brownish from the effects of low temperatures. Light, local, or generalized light browning of needles is not usually considered a character of risk. However, in some areas cold injury may be so severe as to cause a cambium injury in addition to a foliage injury. Severe injuries may have a considerable effect on the risk from insect attack. Care should be taken not to confuse low temperature browning with needle blight.

Cone Fade. Often in heavy seed years, needles behind the cones may fade and die. Apparently this fading has no relation to risk.

Natural Needle Fall. In the late summer or early fall, the normal fading and fall of the old needle complement may create an appearance of high risk, but should not be counted as a factor in determining the risk of individual trees.

Natural Shading Out of Branches. In a fairly closed canopy the lower branches lose their foliage and die. Such natural shading out of branches does not indicate high risk. This must be differentiated from the dying of twigs and branches in the upper, unshaded parts of the crown, a condition which is considered a definite indication of high risk from insect attack.